REMARKS

Claims 1-8 remain in this application. Claims 2-8 are as previously presented. Claim 1 was amended for clarity. No new matter has been introduced.

Objection to Oath/Declaration

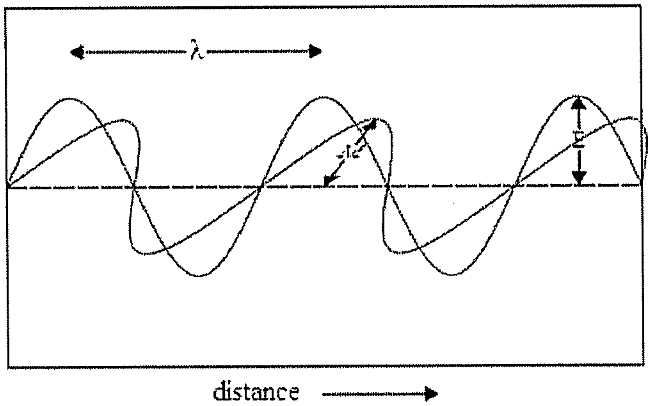
Applicants submit herewith a newly executed declaration.

Rejection under 35 U.S.C. § 102(b)

The Office maintained its rejection of claims 1, 3, and 5-8 under 35 U.S.C. § 102(b) in view of Chow (U.S. Pat. No. 5,240,749). Applicants respectfully disagree.

The Office states that Chow uses microwave energy, which "easily translates into periodic series of high and low energy states". That is, the Office argues that "Chow discloses a periodic pulsed discharge that forms a repeated succession of low and high power states" (Office Action page 3, lines 4-5).

Microwaves are electromagnetic waves with wavelengths longer than 1 mm and shorter than 1 m, or frequencies between 300 MHz and 300 GHz. In other words, microwave's frequency translates to about 3×10^{8}-3×10^{11} events per second. This means that one event occurs every 3×10^{-12} to 3×10^{-9} seconds. Electromagnetic waves are self-propagating, transverse oscillating waves of electric and magnetic fields. Although, the wave's sinusoid is characterized by succession of highs and lows (*amplitude*), it is considered to be a simple harmonic oscillation (see below). In other words, the succession of high and low states in electromagnetic waves is periodic and it repeats itself at standard intervals in a specific manner (sinusoidal, with constant amplitude). Consequently, the electromagnetic waves are not "periodic pulsed" as they do not have a brief and sudden change in the normally constant succession of high and low states, nor is the succession of high and low states periodical in short bursts (both definitions of the term "pulsed" referenced in the previous response).



λ = wavelength
E = amplitude of electric field
M = amplitude of magnetic field

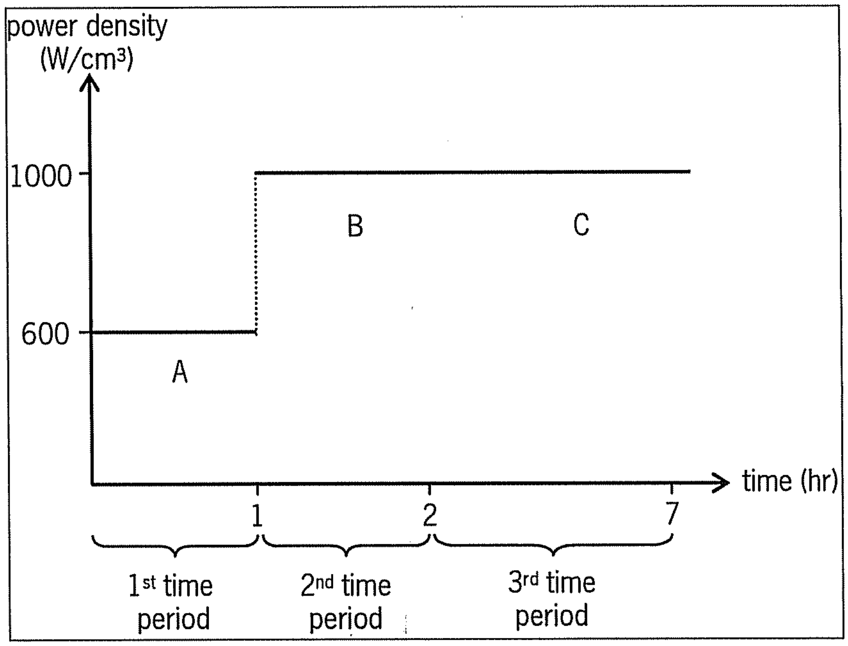
More importantly, it seems that the Office is confusing the oscillations of the electric and magnetic fields of the microwave with the pulses of the power density. As noted above, the succession of high and low states in microwaves is amplitude. Amplitude is a measure of wave's magnitude of oscillation and not a measure of power. For electromagnetic waves such as microwaves, amplitude corresponds to the *electric field* of the wave (units in m). Power that is injected into the plasma, on the other hand, is measured differently (units are watts). Thus, "the frequency of high and low energy states of microwave" can not be interpreted or compared to "a repeated succession of a low-power state and a high-power state, and having a peak absorbed power P_C" that is applied to microwave plasma.

Further, Chow's invention uses microwave energy to grow diamond films. In particular, Chow discloses the method where:

> "The substrate is then irradiated with microwave energy to subject the substrate to a plasma exhibiting a first predetermined power density for a first period of time sufficient to form, on the substrate, diamond-like ball structure particles. The power density of the plasma to which the substrate is exposed is then effectively increased to a second predetermined power density and the substrate in exposed to the plasma for a second period of time sufficiently long such that (100) diamond faces grow on top of the ball structure particles. Finally, the irradiation of the substrate with the diamond-like ball structure particles thereon is continued at the second predetermined power density for a third period of time sufficient to cause the (100) faces on top of the particles to be joined together into a substantially continuous diamond film." (see Abstract, emphasis added)

Thus, Chow clearly applies *two successive, constant* power densities using microwave energy (Chow uses a 100 W 2.45 GHz microwave generator as a source of energy; 3, line 38. The first power density occurs in the 1^{st} step and has duration of one hour (A, see Chow Figure bellow). The second power density, which has the higher power level than the first, occurs in the

2nd step and has duration of one hour (B); and in the 3rd step and has duration of five to six hours (C).

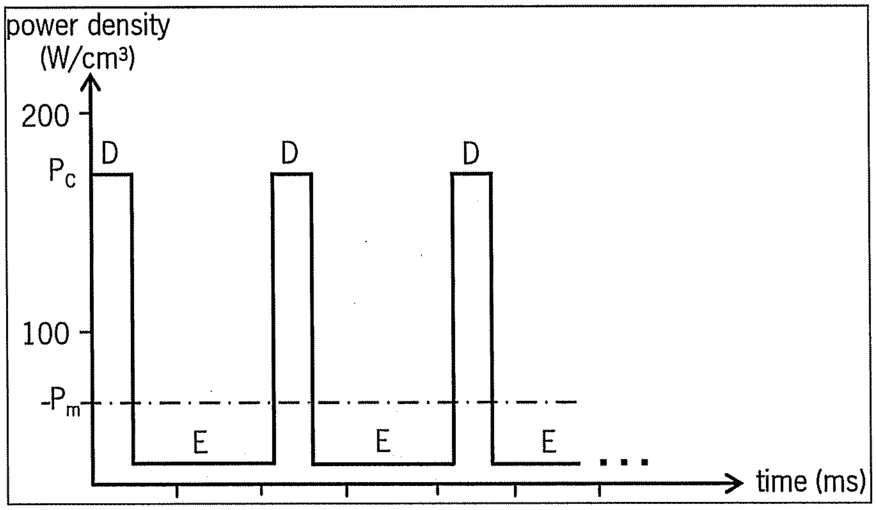


Chow Figure: step *A* forms diamond-like ball; step *B* forms diamond faces on top of the diamond-like ball; and step *C* causes the faces on top of the particles to be joined together into a semi-continuous diamond.

It is clear from the illustration that Chow applies two power densities. The transition between the two power densities is done by only *one* "increase" after 1 hour. Applicants maintain that Chow does not disclose that this "increase" in power is *brief*, *sudden*, or *abrupt*, nor that is *periodical in short burst*. Nor does Chow disclose or suggest that these two power densities are repeated. That is, they cannot be considered to be periodic, since they don't recur at intervals of time. Although the microwave energy Chow uses is periodic, the application that this energy is utilized for (two power densities) is neither periodic nor pulsing.

The currently claimed invention also utilizes microwaves as a source of energy for the manufacture of a diamond film. In particular, the microwaves used are 2.45 GHz and 915 MHz, see page 5, lines 16-17 of the specification. However, the currently claimed method also comprises the additional feature of applying *periodic pulsed* discharges, forming a *repeated* succession of a low-power state and a high-power state (see Invention Figure below). The repeated succession of low power and high power state (P_C) is performed on a millisecond scale (the standby

time T_{OFF} is less than the lifetime of H-atoms in the plasma (page 9, lines 29–34), and the lifetime of H-atom in the plasma is estimated in the literature to be about 2 milliseconds).



Invention Figure: step D increases the characteristics of the plasma (high concentration of atoms H and C-containing radicals), thus high deposition rate; and step E decreases the mean power of discharge, thus the wall temperature remain low and less H-atoms recombine.

In summary, both Chow and the current invention use microwave plasma to manufacture a diamond film. The difference is that Chow applies that energy at two different power levels on an hour time scale. The currently claimed method pulses that energy producing a repeated succession of high-power and low-power state on a millisecond time scale.

Furthermore, Applicants submit that Chow's method has the same deficiencies as the prior art described on page 1, lines 8-17 of this application. The currently claimed method is directed toward curing these deficiencies.

In view of the foregoing, the Chow reference does not disclose the currently claimed invention. Thus, the applicants respectfully request reconsideration and withdrawal of the § 102(b) rejections of claims 1, 3, and 5-8.

Rejections under 35 U.S.C. § 103(a)

Claims 1-8 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Miyanaga *et al.* (U.S. Pat. No. 5,626,922). Applicants respectfully traverse this rejection.

The Office alleges that Miyanaga discloses "plasma CVD method using a pulsed microwave plasma to deposit a diamond film (abstract and examples)" (Office Action page 6,

lines 3-4). The Office, however, disregards the entire scope of the prior art. That is, Miyanaga's invention is directed to process of depositing films by chemical vapor deposition (CVD), "which takes advantage of the interaction between a magnetic field and an electric field, e.g. a high frequency electric field" (columns 1, lines 60-67). Miyanga summarizes their invention in column 3, lines 16-20:

> "the process according to the present invention utilizes plasma grow discharge and comprises a known microwave plasma CVD process to which a magnetic field is added to utilize the interaction of the magnetic field with the high frequency (micro wave) electric field."

As a source of high frequency electric field, Miyanaga uses microwaves, whereas as a source of magnetic field, Miyanaga applies electric energy intermittently, or supplies either a DC current or a pulsed current to a Helmholtz coil (see column 2, lines 2-11). Examples 1-3 describe processes wherein Helmholtz coils (5 and 5') were used as a source of magnetic field. The microwave of 2.45 GHz was applied to the system, along with 2 KGauss of magnetic filed (column 5, lines 31-35).

Therefore, Miyanaga discloses a method for growing films where <u>magnetic field is applied in addition to microwave energy</u>. There is no teaching, suggestion, or motivation in Miyanaga to use microwave energy without also applying magnetic field. Thus, a person of ordinary skill in the art, upon considering the Miyanaga patent, would not be motivated to use *only* pulsed microwave plasma to manufacture a diamond film. Therefore, Miyanaga *et al.* does not render the currently claimed invention obvious.

Claims 2, 4, and 7-8 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Chow in view of Kawarada *et al.* Applicants respectfully traverse this rejection.

As discussed above, Chow discloses a method wherein the power densities are applied increasingly in a stair-like manner on hour time scale. Chow does not disclose or suggest the use of the periodic pulsed discharges in the manufacturing of a diamond film. The use of the <u>*periodic*</u> pulsed discharge aims at improving the growth rate of the diamond films manufacturing as discussed in the previous Office Action response.

Kawarada *et al.*, which discloses the range of the plasma temperature and density, does not cure the deficiencies of the Chow reference. Combining Chow and Kawarada would afford a

method that does not use the pulsed discharges of the current claims, so the combined references do not make the currently claimed invention obvious.

Further, in order to obtain the method of the present invention, the person of ordinary skill in the art, having the Chow and Kawarada *et al.* references at hand, would need to, at a minimum:

1. substantially decrease the duration of each plateau, from about 1h to a few ms;
2. repeat the application of a low-power state and a high-power state, in order to obtain a periodic signal, forming a repeated succession of a low-power state and a high-power state; and
3. determine, according to the conditions of the invention and the desired growth rate, the respective power densities of the low-power state and the high-power state, as well as the ratio of their duration.

All of these would have to be done even though there is no teaching, suggestion, motivation, or reason for the person of ordinary skill in the art to do so. Further, to do so would require the person of ordinary skill in the art to perform a great number of experiments, calculations and simulations on the plasma modelling to modify the method disclosed by Chow in order to obtain the claimed method. Without a reason to do so, Applicants fail to see how the person of ordinary skill in the art would come up with the currently claimed invention. This implies that the differences between the claimed method and Chow in light of Kawarada *et al.* are not obvious.

In view of the above arguments, the applicants respectfully request reconsideration and withdrawal of the § 103(a) rejection of claims 2, 4, and 7-8.

CONCLUSION

Applicants respectfully contend that all requirements of patentability have been met. Allowance of the claims and passage of the case to issue are therefore respectfully solicited.

The Examiner is urged to contact the Applicants' undersigned representative at (312) 913-2114 if the Examiner believes a discussion would expedite prosecution of this application.

Respectfully submitted,

Date: December 12, 2007

Brad Crawford

Bradley W. Crawford
Registration No. 50,494

McDonnell Boehnen Hulbert & Berghoff LLP
300 South Wacker Drive
Chicago, IL 60606

Telephone: 312-913-2114
Facsimile: 312-913-0002